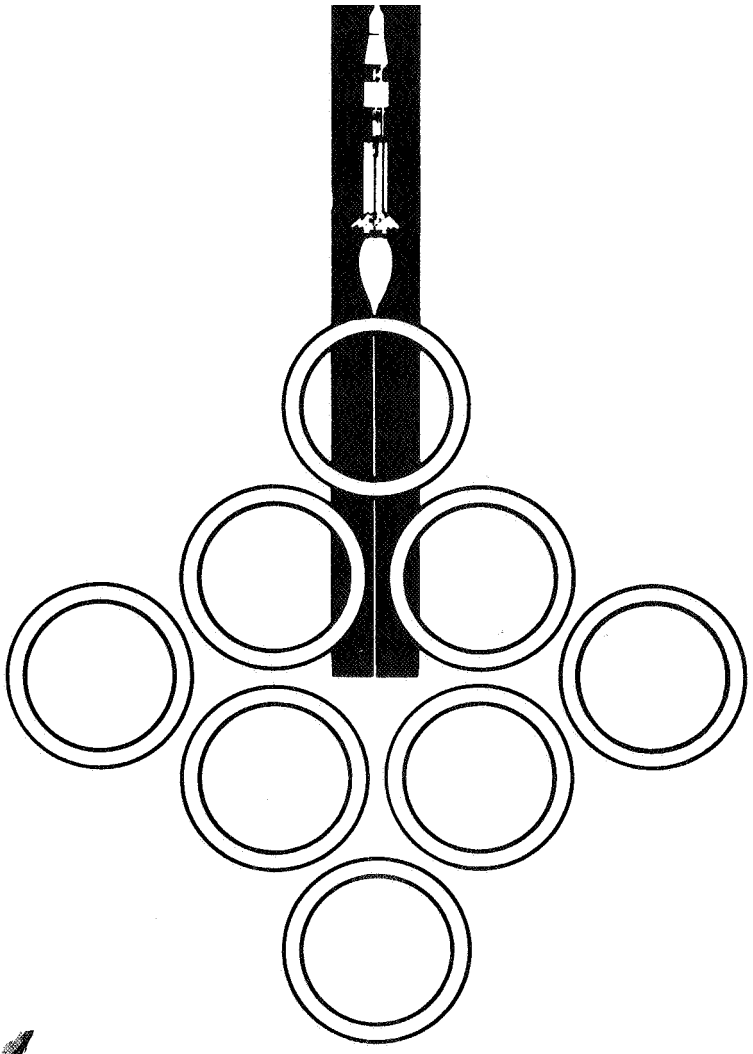

ENGINEERING DEPARTMENT

TECHNICAL REPORT

TR-RE-CCSD-FO-1106-3

July 24, 1967

SATURN IB PROGRAM

TEST REPORT
FOR

PRESSURE SWITCH

Parmatic, Incorporated - Part Number AP535-4

NASA Drawing **Number** A75M04044-HPS-1

SPACE DIVISION CHRYSLER CORPORATION

TEST REPORT

FOR

PRESSURE SWITCH

Parmatic, Incorporated Part Number AP535-4

NASA Drawing Number A75M04044-HPS-1

ABSTRACT

This report presents the results of tests performed on 3 specimens of Pressure Switch A75M04044-HPS-1. The following tests were performed:

1. Receiving Inspection
2. Proof Pressure
3. Functional
4. Low Temperature
5. High Temperature
6. Vibration
7. Salt Fog
8. Explosion
9. Cycle

The actuation pressure of specimen 1 was out of tolerance during the initial functional, low and high temperature tests, vibration and cycle tests and after the temperature and salt fog tests. The insulation resistance was below specification levels after the temperature tests.

The actuation pressure of specimen 2 was out of tolerance during the initial functional and cycle tests and after the temperature and explosion tests, The contact voltage drop between pins A and B exceeded the specified level after 2, 3, 4, and 5 thousand cycles of the cycle test,

The actuation pressure of specimen 3 was out of tolerance during the initial functional and after the salt fog test.

Specimen 1 would not operate prior to the explosion test due to deterioration caused by the salt fog test. The unit was disassembled and cleaned by CCSD personnel after the explosion test and testing was continued.

Specimen 3 would not operate prior to the cycle tests due to deterioration caused by the salt fog test.

TR-RE-CCSD-FO-1106-3

TEST REPORT

FOR

' PRESSURE SWITCH

Parmatic, Incorporated Part Number AP535-4

NASA Drawing Number A75M04044-HPS-1

July 24, 1967

CHRYSLER CORPORATION SPACE DIVISION - NEW ORLEANS, LOUISIANA

FOREWORD

The tests reported herein were conducted for the John F. Kennedy Space Center by Chrysler Corporation Space Division (CCSD), New Orleans, Louisiana, This document was prepared by CCSD under contract NAS 8-4016, Part VII, CWO 271620.

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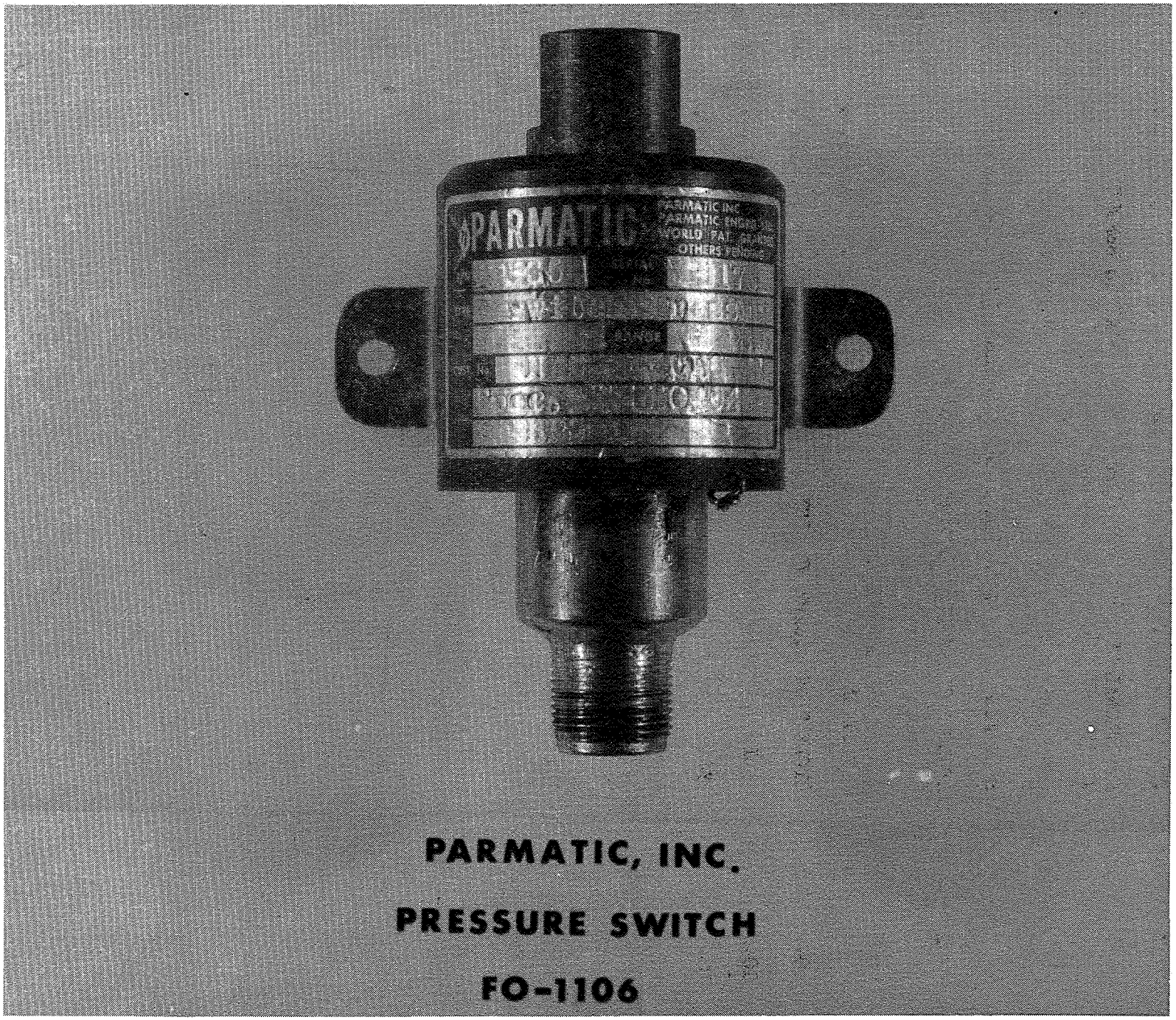


PRESSURE SWITCH A75M04044-HPS-1

CHECK SHEET

FOR

PRESSURE SWITCH

MANUFACTURER: Parmatic, Incorporated, Newark, New Jersey
MANUFACTURERS PART NUMBER: AP535-4
NASA DRAWING NUMBER: A75M04044-HPS-1
TESTING AGENCY: Chrysler Corporation Space Division, New Orleans, Louisiana
AUTHORIZING AGENCY: NASA KSC

I. FUNCTIONAL REQUIREMENTS

A.	OPERATING MEDIA:	GH_2, GHe, GN_2
B.	OPERATING PRESSURE:	Actuates on decreasing pressure at 2.00(±0.01) psig; deactuates at or before 3.00 psig on increasing pressure.
C.	ADJUSTABLE RANGE:	Field adjustable to ±10 percent of factory setting.
D.	LEAKAGE:	2.9×10^{-4} standard cc He/sec/inch of seal (maximum) at a pressure differential of 1 atmosphere.
E.	PROOF PRESSURE:	120 psig
F.	CONTACT READING:	5 amperes, dc resistive

II. CONSTRUCTION (MECHANICAL)

A.	PRESSURE ELEMENT:	Spring-return pneumatic piston
B.	PNEUMATIC CONNECTION:	AND 10050-4
C.	WEIGHT:	7 ozs.

III. CONSTRUCTION (ELECTRICAL)

A.	CONNECTOR:	600450-H-14S-7P
B.	CONTACT VOLTAGE DROP:	0.300-vdc maximum at rated load

IV. ENVIRONMENTAL CHARACTERISTICS (MANUFACTURER'S SPECIFICATIONS)

	TEMPERATURE RANGE:	+30 to +130°F

V. LOCATION AND USE:

A.	LOCATION:	LH_2 transfer system and LH_2 storage tank pressurization subsystem
B.	USE:	Actuates when storage tank ullage pressure decreases to below 2 psig to close the storage tank rent valve during line drain sequence.

TEST SUMMARY

PRESSURE SWITCH

75M04044-HPS-1

Environment	Units	Operational Boundary	Test Objective	Test Results	Remarks
Receiving Inspection	1,2,3	Visual Inspection	To determine if specimens conform with applicable drawings and specifications	S	
Proof Pressure Test	1,2,3	120 psig for 10 minutes	Maintain 120 psig	S	
Initial Function Teat a. Actuation and Deactuation	1,2,3	Deactuate on increasing pressure at or before 3,00 psig; Actuate on decreasing pressure at 2.00 (±0.01) psig	Actuate and deactuate test specimens at specified levels	U	Improper Actuation Pressure
b. Contact Voltage Drop	1,2,3	Apply a 5-ampere, 28 vdc resistive load across closed contacts	Voltage drop shall not exceed 300 millivolts	S	
c. Insulation Resistance	1,2,3	500 vdc applied between non-connected pins and between each pin and switch case	Insulation resistance not less than 20 megohms	S	
d. Dielectric strength	1,2,3	1000 vac(rms), 60 cps applied between non-connected pins and between each pin and switch case	Leakage current not greater than 5 milliamperes	S	

TEST SUMMARY

PRESSURE SWITCH

(CONTINUED)

Environment	Units	Operational Boundary	Test Objective	Test Results	Remarks
e. Seal Leakage Test	1,2,3	Pressure differential of 1 atmosphere	Leakage rate shall not exceed 2.9 x 10⁻⁴ standard cc of helium/second/inch of seal	S	
f. Adjustability Test	1,2,3	Adjustable to plus or minus 10 percent of specified actuation pressure	Actuate at 2.20 psig or more (maximum setting) actuate at 1.80 psig or less (minimum setting).	S	
Low Temperature Test	1	Stabilize at 30°F, perform a functional test at low temperature, and return to ambient conditions	Determine operating ability at low temperature and after returning to ambient conditions	U	Improper actuation pressure; low insulation resistance
	2			U	Improper actuation pressure
High Temperature Test	1	Stabilize at 130°F, perform a functional test at high temperature, and return to ambient conditions	Determine operating ability at high temperature and after returning to ambient conditions	U	Improper actuation pressure; low insulation resistance
	2			U	Improper actuation pressure

TEST SUMMARY

PRESSURE SWITCH

(CONTINUED)

Environment	Units	Operational Boundary	Test Objective	Test Results	Remarks
Vibration Test a. Resonant Frequency Search	1 & 2	Vibrate specimens far 15 minutes from 5 to 2000 to 5 cps at specified input levels	Determine resonant frequencies of test specimens	S	
b. Sinusoidal Sweep	1 & 2	Vibrate specimens for 20 minutes from 10 to 2000 to 10cps at specified input levels	Determine operating ability during vibration and after being subjected to a vibration environment	U	Improper actuation pressure
c. Random Excitation	1 & 2	Vibrate specimens for 5 minutes at specified input level	Determine operating ability during vibration and after being subjected to a vibration environment	U	Improper actuation pressure
Salt Fog Teat	1 & 3	5% by weight mixture salt solution, maintain for 240 hours at 95°F	Determine performance after being subjected to salt fog environment	U	Improper actuation pressure
Explosion Test	2	32% by volume hydrogen, 160°F at 13.1 psig	Operate switch in explosive atmosphere	S	
Cycle Test	1 & 2	Actuate and deactuate each specimen for 5000 cycles	Determine effect of continuoue operation on specimen performance	U	Improper actuation pressure

S - Satisfactory

U - Unsatisfactory

SECTION I

INTRODUCTION

11 SCOPE

This report presents the results of teats that were performed to determine if Pressure Switch 75M04044-HPS-1 meets the operational and environmental requirements of the John F. Kennedy Space Center. A summary of the teat results is presented on pages viii through x.

1.2 ITEM DESCRIPTION

1.2.1 Three specimens of Pressure Switch 75M04044-HPS-1 were tested. The switches are manufactured by Parmatic, Incorporated as vendor part number AP535-4. The switch is adjusted to operate on increasing pressure at or before 3.00 psig and on decreasing pressure at 2.00 psig with an adjustable range of 10 percent.

1.2.2 The switch is mounted by means of a support bracket which is riveted to the switch housing, The switch will be used in a LH_2 storage tank pressurization subsystem.

1.3 APPLICABLE DOCUMENTS

The following documents contain the test requirements for Pressure Switch 75M04044-HPS-1:

a. KSC-STD-164(D), Standard Environmental Test Methods for Ground support Equipment Installations at Cape Kennedy,

b. NASA Drawing A75M04044-HPS-1

c. Test Plan CCSD-FO-1106-1F, Revision C

14 SPECIMEN ASSIGNMENT NUMBERS

The specimen assignment numbers are as follows:

Specimen	Serial Number	Manufacturer's Part Number
1	91700	AP535-4
2	91701	AP535-4
3	91702	AP535-4

SECTION II

RECEIVING INSPECTION

21 TEST REQUIREMENTS

Each specimen shall be visually and dimensionally inspected for conformance with the applicable specifications prior to testing.

22 TEST PROCEDURE

A visual and dimensional inspection was performed to determine compliance with NASA drawing 75M04044-HPS-1 and to the applicable vendor drawings, to the extent possible without disassembly of the test specimens. At the same time, each test specimen was also inspected for poor workmanship and manufacturing defects.

23 TEST RESULTS

The specimens were found to conform with all applicable drawings and specifications.

SECTION III

PROOF PRESSURE TEST

3.1 TEST REQUIREMENTS

3.1.1 The test specimens shall be pressurized to 120 psig for 10 minutes, using gaseous helium.

3.1.2 The test specimens shall be inspected for leakage and external damage.

3.2 TEST PROCEDURE

3.2.1 The test setup was assembled as shown in figure 3-1, using the equipment listed in table 3-1.

3.2.2 The test specimen was pressurized to the rated proof pressure by closing hand valve 5 and adjusting pressure regulator 3.

3.2.3 The specimens were checked for leakage during the 10 minute period by monitoring gage 4 for an indication of a pressure drop in the specimens. The initial and final pressures were recorded.

3.2.4 Pressure regulator 3 was closed and hand valve 5 was opened to depressurize the specimens.

3.2.5 The specimens were removed from the test setup and inspected for damage.

3.3 TEST RESULTS

There was no leakage of the test specimens and there was no evidence of internal or external damage.

3.4 TEST DATA

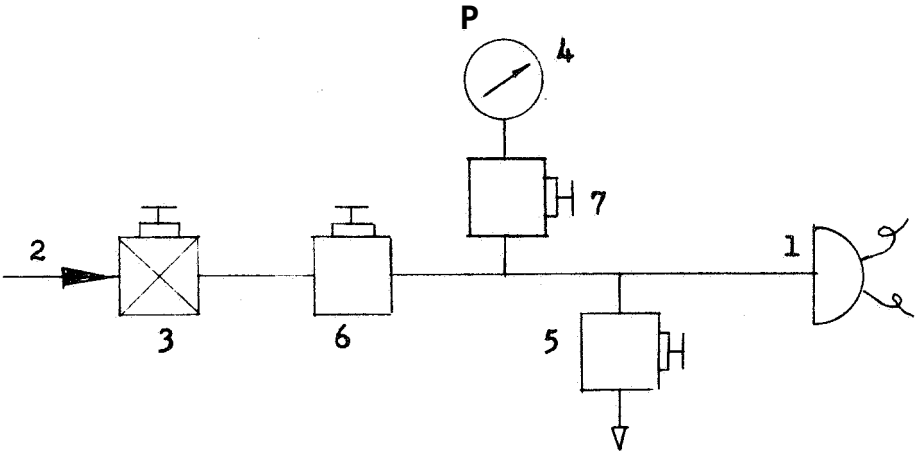
The test data presented in table 3-2 were recorded during the test.

Table 3-1. Proof Pressure Test Equipment List

Item No.	Item	Manufacturer	Model/ Part No.	Serial No.	Remarks
1	Test Specimens 1, 2, and 3	Parmatic, Inc.	AP535-4	91700 91701 91702	Pressure Switch
2	Helium Supply	NA	NA	NA	120 psig
3	Pressure Regulator	Tescom Corp.	26-1002	1009	500 psig
4	Pressure Gage	Heise	1335225	012448	0 to 1000 psig ±0.1% FS Cal.date: 5/3/67
5	Relief Valve	Robbins	ANA 250-4T	NA	1/4-in.
6	Hand Valve	Robbins	ANA 250-4T	NA	1/4-in.
7	Hand Valve	Robbins	ANA 250-4T	NA	1/4-in.

Table 3-2. Proof Pressure Test Data

SPECIMEN NUMBER	PRESSURE (psig)	TIME (MINUTES)	LEAKAGE	EXTERNAL DAMAGE
1	120	10	NONE	NONE
2	120	10	NONE	NONE
3	120	10	NONE	NONE



Note: Refer *to* table 3-1 for item identification

All line sizes 1/4 - inch.

Figure 3-1. Proof Pressure Test Schematic

SECTION IV

FUNCTIONAL TEST

4.1 TEST REQUIREMENTS

4.1.1 Actuation of the test specimen shall occur on decreasing pressure at 2.00(±0.01) psig.

4.1.2 Deactuation of the test specimen shall occur on increasing pressure either at or before 3.00 psig.

4.1.3 Contact voltage drop across the normally open and the normally closed contacts shall not exceed 300 millivolts when a 5-ampere, 28 vdc resistive load is applied to the contacts (contacts in closed position).

4.1.4 The insulation resistance, when measured between all nonconnected pins and between each pin and the case, shall not be less than 20 megohms with 500 vdc applied.

4.1.5 The dielectric strength shall be such that the leakage current shall not exceed 5 milliamperes when 1000 vac(rms), 60 cps is applied.

4.1.6 The seal leakage rate shall not exceed 2.9×10^{-4} standard cc of helium/second/inch of seal at a pressure differential of 1 atmosphere.

4.1.7 The test specimen shall be adjustable to plus or minus 10 percent of the factory setting.

4.2 TEST [illegible]

4.2.1 The test setup was assembled as shown in figures 4-1 and 4-2, using all the equipment listed in table 4-1 except items 9 through 13.

4.2.2 Hand valves 3 and relief valve 5 were opened and the system was purged of air using a low flow from the regulated source.

4.2.3 Relief valve 5 was closed and the regulated source pressure was slowly increased until the specimen deactuated. The deactuation pressure was recorded.

4.2.4 The regulated source pressure was slowly decreased until the specimen actuated. The actuation pressure was recorded and the pressure was reduced to zero.

4.2.5 Steps 4.2.3 and 4.2.4 were repeated until each test specimen was actuated and deactuated five times.

4.2.6 Lamps 7 and 8 were removed from the test setup and replaced with load banks 12 which were adjusted to 5-ampere loads at 28 vdc.

4.2.7 Differential voltmeter 9 was connected across pins A and B of J1, and the contact voltage drop across the normally open contacts was measured and recorded.

4.2.8 The differential voltmeter was disconnected and the regulated source pressure was slowly increased until the specimen deactuated,

4.2.9 Differential voltmeter 9 was connected across pins B and C of J1 and the contact voltage drop across the normally closed contacts was measured and recorded.

4.2.10 The electrical portions of the test setup were removed by disconnecting P1 (figure 4.2) and the regulated source pressure was reduced to zero.

4.2.11 Megohmmeter 11 was connected to pins B and C of J1, and with 500 vdc applied to the pins the insulation resistance was measured and recorded.

4.2.12 Megohmmeter 11 was connected to pins A and B of J1 and the test specimen was deactuated. The 500 vdc test voltage was applied and the insulation resistance was measured and recorded.

4.2.13 The insulation resistance between each pin of J1 and the test specimen case was measured and recorded by applying 500 vdc between the pins and case.

4.2.14 The megohmmeter was removed and the insulation tester 10 was connected between pins A and C of J1 and the specimen case with the test specimen in the deactuated position.

4.2.15 The test voltage was gradually increased from zero to 1000 vac (rms) and was maintained for 60 seconds. The highest leakage current was recorded.

4.2.16 The regulated source pressure was reduced to zero and the insulation tester was connected between pins C and A of J1 and the specimen case. Step 4.2.15 was then repeated.

4.2.17 The test specimen was placed in vacuum chamber 3 and the chamber was then evacuated to maximum vacuum.

4.2.18 Helium was applied to the inlet of the test specimen to create a differential pressure of one atmosphere between the specimen and the vacuum chamber,

4.2.19 Mass spectrometer 2 was used to measure helium leaking from the test specimen.

4.2.20 The vacuum chamber was returned to ambient conditions and the test specimen was removed.

4.2.21 The test specimen was connected into the test setup as specified in 4.2.1.

4.2.22 The adjustment screw was turned fully clockwise and the maximum operating pressures were measured and recorded.

4.2.23 The adjustment screw was then turned fully counter clockwise and the minimum operating pressures were measured and recorded.

4.2.24 The test specimen was reset to the specified actuation pressure setting.

4.3 TEST RESULTS

4.3.1 Specimens 1, 2, and 3 actuated above the levels specified in 4.1.1.

4.3.2 The contact voltage drop was less than 300 millivolts for all measurements.

4.3.3 The insulation resistance was greater than 20 megohms for all measurements.

4.3.4 The dielectric strength (leakage current) was less than 5 milliamperes for all measurements.

4.3.5 Specimen seal leakage was less than 2.9×10^{-4} standard cc of helium 1 second/inch of seal.

4.3.6 The test specimens were adjustable to the levels specified in 4.1.7. Each specimen was reset to the specified pressure after the adjustability test.

4.4 TEST DATA

Data recorded during the initial functional test are presented in tables 4-2 and 4-3.

Table 4-1. Functional Test Equipment List

Item NO.	Item	Manufacturer	Nodel/ Part No.	Serial No.	Remarks
1	Teat Specimens 1, 2, and 3	Parmatic, Inc.	AP 535-4	91700 91701 91702	Pressure Switch
2	Regulated Helium Source	NA	NA	NA	5 psig
3	Hand Valve	Grove	10903A	NA	1/4-in.
4	Pressure Gage	Wallace-Tierman	FA234	HH11924	0 to 50 psig, ±0.1% FS Cal.date:3/20/67
5	Relief Valve	Robbins	ANA 250-4	NA	1/4-in.
6	Power Source	Lambda	LA5003B	010270	28 vdc, 5 amperes
7	Lamp (DS1)	General Electric	327	NA	Green
8	Lamp (DS2)	General Electric	327	NA	Orange
9	Differential Voltmeter	John Fluke	821A	156	±0.1% FS accuracy
10	Insulation Testa	Wiley	5	015241	
11	Megohmmeter	General Radio	1862-B	01845	
12	Load Bank	CCSD	NA	NA	5-ampere, 28 vdc
13	Ammeter	Simpson	NA	NA	0-to 10-ampere 1% FS accuracy

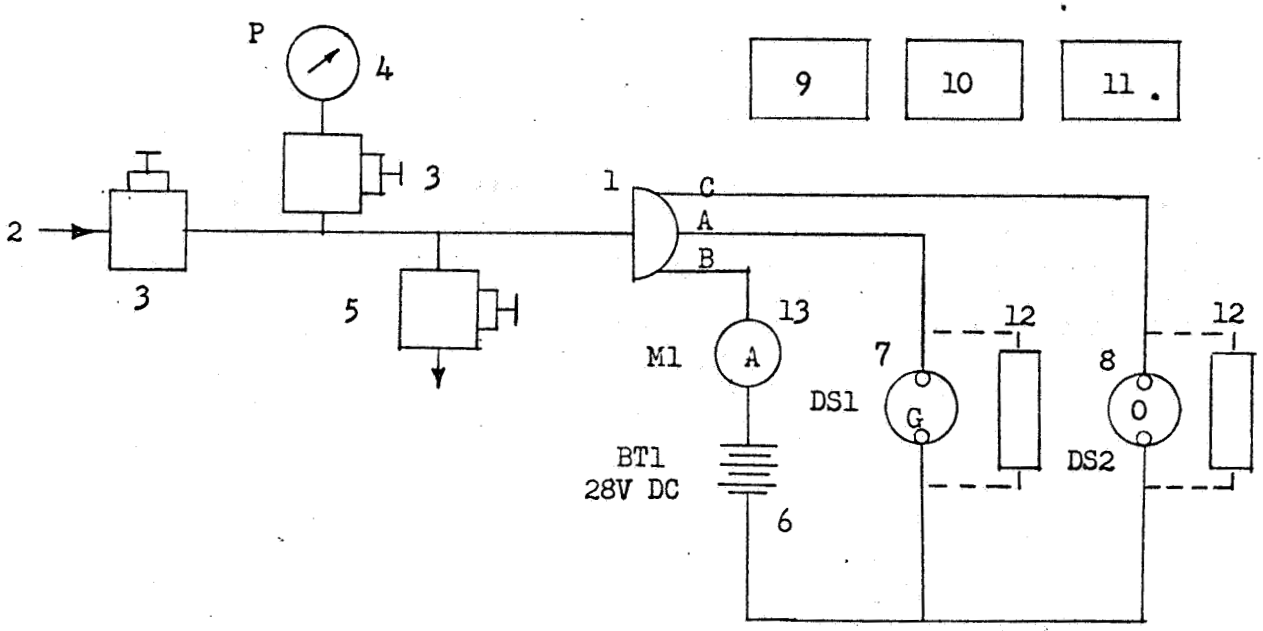
Table 4-2. Initial Functional Test Operating Pressures

SPECIMEN NUMBER	SERIAL NUMBER	AVERAGE ACTUATION PRESSURE (psig)	SPECIFIED ACTUATION PRESSURE (psig)	AVERAGE DEACTUATION PRESSURE (psig)	SPECIFIED DEACTUATION PRESSURE (psig max.)
1	91700	*4.23	2.0(±0.01)	* 4.90	3.00
2	91701	*4.31	2.00(±0.01)	* 3.30	3.00
3	91702	*4.59	2.00(±0.01)	* 3.38	3.00

* Out of Tolerance

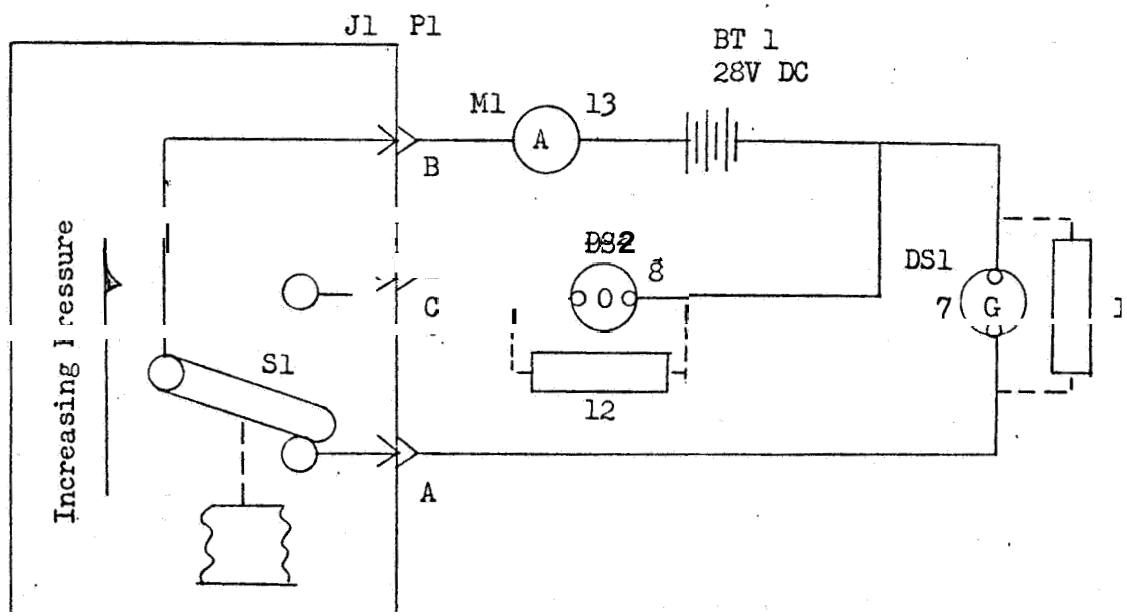
Table 4-3. Initial Functional Adjustability Test Data

SPECIMEN NUMBER	SERIAL NUMBER	MAXIMUM ACTUATION PRESSURE (psig)	SPECIFIED ACTUATION PRESSURE (psig min.)	MINIMUM ACTUATION PRESSURE (psig)	SPECIFIED ACTUATION PRESSURE (psig max.)
1	91700	7.07	2.20	0.06	1.80
2	91701	6.24	2.20	0.04	1.80
3	91702	6.22	2.20	0.14	1.80



Note: Refer to table 4-1 for item identification.
All lines $\frac{1}{4}$ inch.

Figure 4-1. Functional Test Schematic



Note: Refer to table 4-1 for item identification,
All lines $\frac{1}{4}$ inch.

Figure 4-2. Functional Test Wiring Schematic

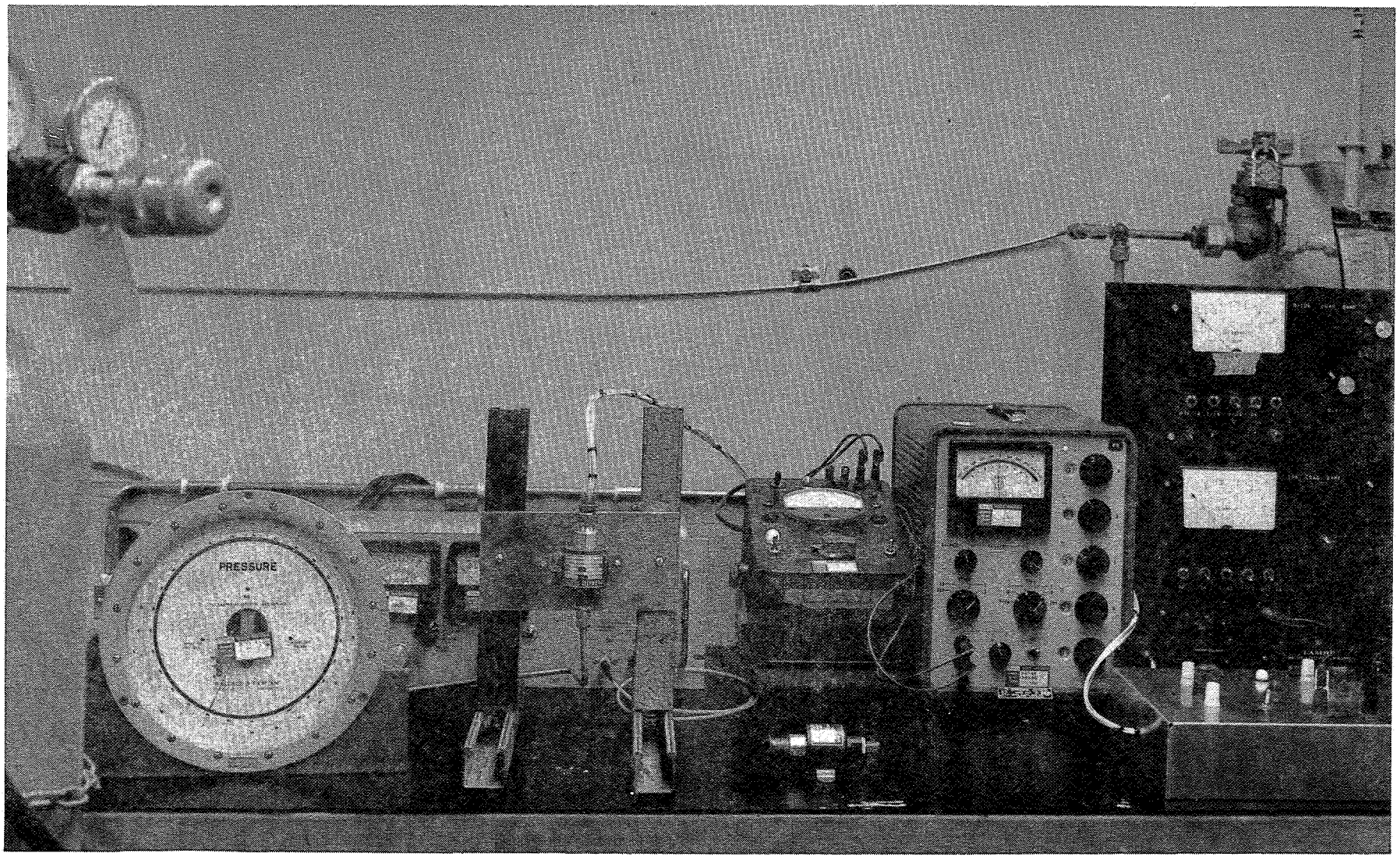


Figure 4-3. Functional Test Setup

SECTION V

LOW TEMPERATURE TEST

5.1 TEST REQUIREMENTS

5.1.1 Test specimens 1 and 2 shall be subjected to a low temperature test of 30(+0, -4)°F to determine whether the environment causes degradation or deterioration of the specimens.

5.1.2 A functional test as prescribed in Section IV shall be performed before the test (if more than 72 hours has elapsed since the last functional test), during the test, and within 1 hour after stabilization at ambient temperature after the test. Paragraphs 4.1.6 and 4.1.7 may be omitted.

5.2 TEST PROCEDURE

5.2.1 The test specimens were placed in the low temperature chamber and all necessary electrical and pneumatic systems were connected.

5.2.2 A functional test was performed according to Section IV. Paragraphs 4.1.6 and 4.1.7 Were omitted.

5.2.3 The chamber temperature was decreased at the rate of one degree per minute and stabilized at 30 (+0, -4)°F.

5.2.4 A functional test (refer to 5.1.2) was performed when temperature stabilization was attained.

5.2.5 The chamber temperature was returned to ambient upon completion of the functional test.

5.2.6 The test specimens Mere Visually inspected and functionally tested within 1 hour following the return to ambient.

5.3 TEST RESULTS

5.3.1 Test specimen 1 actuated below the level specified in 4.1.1 during and after the low temperature test.

5.3.2 Test specimen 2 actuated below the level specified in 4.1.1 after the low temperature test.

5.3.3 The insulation resistance between pin B and case and between pin C and case of specimen 1 was less than 20 megohms after the low temperature test.

5.4 TEST DATA

Data recorded during the low temperature functional tests are presented in table 5-1.

Table 5-1. Low Temperature Functional Test Operating Pressures

TEMPERATURE TEST	SPECMEN 1		SPECIMEN 2	
	AVERAGE ACTUATION (psig)	AVERAGE DEACTUATION (psig)	AVERAGE ACTUATION (psig)	AVERAGE DEACTUATION (psig)
BEFORE	2.00	2.50	2.00	2.70
DURING	* 1.72	2.46	2.00	2.70
AFTER	* 1.70	2.41	* 1.90	2.62

* Out of Tolerance

Specification Levels

Actuation: 2.00($\pm$0.01) psig

Deactuation: 3.00 psig max.

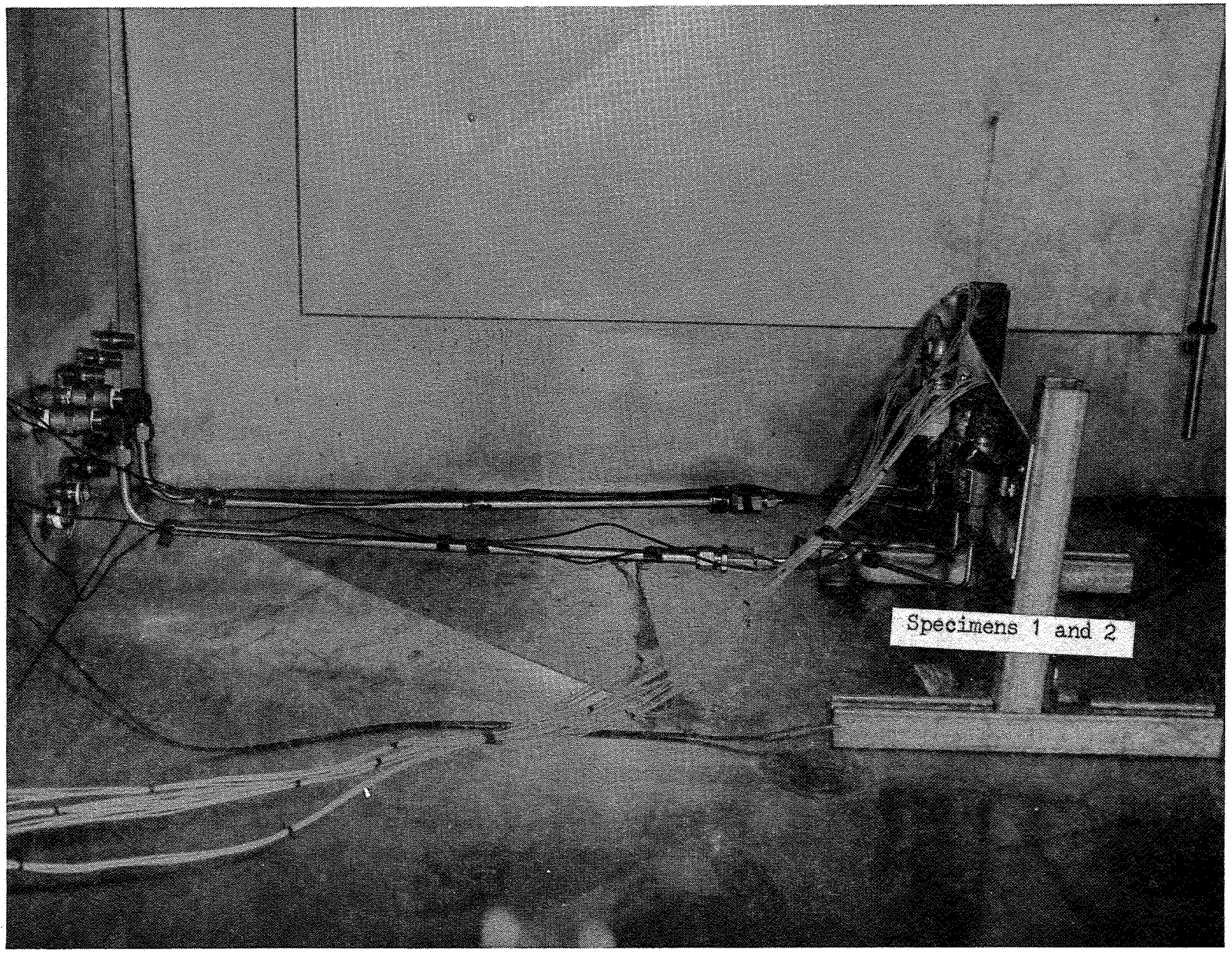


Figure 5-1. Temperature Test Setup

SECTION V I

HIGH TEMPERATURE TEST

6.1 *TEST REQUIREMENTS*

6.1.1 Test specimens 1 and 2 shall be subjected to a high temperature test of 130 (+4, -0)°F to determine Whether the environment causes degradation or deterioration of the specimens.

6.1.2 A functional test as prescribed in section IV shall be performed before the test (if more than 72 hours has elapsed since the last functional test), during the test, and within 1 hour after stabilization at ambient temperature *after* the test. Paragraphs 4.1.6 and 4.1.7 *may* be omitted.

6.2 TEST PROCEDURE

6.2.1 The test specimens were placed in the high temperature chamber and all necessary electrical and pneumatic systems were connected,

6.2.2 A functional test was performed according to Section IV. Paragraphs 4.1.6 and 4.1.7 were omitted.

6.2.3 The chamber temperature was increased at the rate of one degree per minute and stabilized at 130 (+4, -0)°F.

6.2.4 A functional test (refer to 6.1.2) was performed when temperature stabilization was attained.

6.2.5 The chamber temperature was returned to ambient upon completion of the functional test.

6.2.6 The test specimens were visually inspected and functionally tested within 1 hour following the return to ambient.

6.3 TEST RESULTS

6.3.1 Test specimens land 2 operated below the level specified in 4.1.1 during and after the high temperature test,

6.3.2 The insulation resistance between pin B and case and between pin C and case of specimen 1 was less than 20 megohms during each functional teat (specimen in deactuated position). The insulation *re*-sistance between pin A and case and between pin B and case was less than 20 megohms with the specimen in the actuated position.

6.4 TEST DATA

Data recorded during the high temperature functional tests are presented in Tables 6-1 and 6-2.

Table 6-1. High Temperature Functional Test Operating Pressures

Temperature Test	Specimen 1		Specimen 2	
	Average Actuation (psig)	Average Deactuation (psig)	Average Actuation (psig)	Average Deactuation (psig)
Before	2.00	2.84	1.99	2.78
During	*1.95	2.91	*1.85	2.54
After	*2.21	2.83	*2.03	2.83

* Out of Tolerance

Specification Levels

Actuation: 2.00(±0.01) psig

Deactuation: 3.00 psig max.

Table 6-2. High Temperature Test Insulation Resistance Measurements

Temperature Test	Measurement Points		Insulation Resistance (Megohms)			
			Specimen 1		Specimen 2	
	(+)	(-)	Actuated	Deactuated	Actuated	Deactuated
Before	A	Case	NA	1500	NA	1500
	B	Case	NA	* 5	NA	1500
	C	Case	NA	* 5	NA	1500
During	A	Case	* 10	1400	900	1400
	B	Case	* 10	* 10	900	900
	C	Case	1500	* 10	1500	900
After	A	Case	* 4	1800	900	2000
	B	Case	* 3	* 3	900	900
	C	Case	1700	* 3	2000	900

* Out of Tolerance

SECTION VII

VIBRATION TESTS

7.1 TEST REQUIREMENTS

7.1.1 Test specimens 1 and 2 shall be subjected to sinusoidal and random excitation to determine the capability of the specimens to operate satisfactorily during and after vibration testing.

7.1.2 The tests shall be performed in the horizontal and vertical axes (see figure 7-1).

7.1.3 The tests shall be conducted in accordance with section 9, procedure I of KSC-STD-164(D).

7.1.4 Acceleration shall be measured by accelerometors mounted on the test specimens.

7.1.5 The specimens shall be monitored for contact chatter during the sinusoidal sweep and random excitation tests.

7.1.6 A functional test shall be performed prior to the vibration tests and immediately following the sinusoidal sweep and random excitation test in each axis.

7.2 TEST PROCEDURE

7.2.1 The test specimens were installed on a vibration fixture and the fixture was mounted on the vibrator. All necessary electrical and pneumatic systems were connected.

7.2.2 A functional test was performed according to Section IV. Paragraphs 4.1.6 and 4.1.7 were omitted.

7.2.3 The resonant frequency search was performed while vibrating the test specimens at the input levels specified in Table 7-1.

7.2.4 The sinusoidal sweep test was performed by vibrating the test specimen at the levels specified in Table 7-1. The specimen contacts were monitored for chatter with the test specimen pressurized from 10 to 2000 cps and depressurized from 2000 to 10 cps.

7.2.5 A functional test was performed according to Section IV. Paragraphs 4.1.6 and 4.1.7 were omitted.

7.2.6 The random excitation test was performed by vibrating the test specimens at the levels specified in Table 7-1. The specimen contacts were monitored for chatter with the test specimen pressurized for 2.5 minutes and depressurized for 2.5 minutes.

7.2.7 A functional test was performed according to Section IV. Paragraphs 4.1.6 and 4.1.7 were omitted except after the Z-axis random vibration test when 4.1.6 was performed.

7.3 TEST RESULTS

7.3.1 Test specimens 1 and 2 operated below the level specified in 4.1.1 during the first vibration functional test (X-axis sinusoidal sweep). The test specimens were not readjusted after each function test.

7.3.2 No contact chatter was detected during the vibration tests.

7.4 TEST DATA

7.4.1 Data recorded during the vibration functional tests are presented in Tables 7-2 and 7-3.

7.4.2 A typical vibration input plot (acceleration versus frequency) is presented in figure 7-2.

7.4.3 A typical random equalization plot is presented in figure 7-3.

Table 7-1. Vibration Test Levels (X, Y, and Z Axes)

Resonant Frequency Search (15 minute duration)		Sinusoidal Sweep (20 minute duration)		Random Excitation (5 minute duration)	
Frequency (cps)	Level	Frequency (cps)	Level	Frequency (cps)	Level
5 to 44	0.01 in.DA	10 to 44	0.1 in DA	10 to 100	+6db/ octave
44 to 2000	1.0 g peak	44 to 2000	10.0 g peak	100 to 1000	$0.01g^2$/ cps
2000 to 44	1.0 g peak	2000 to 44	10.0 g peak	1000 to 2000	-6db/ octave
44 to 5	0.01 inch DA	44 to 10	0.1 in DA		

Table 7-2. Functional Test Operating Pressures Obtained Before Vibration Tests

Specimen Number	Serial Number	Average Actuation Pressure (psig)	Specified Actuation Pressure (psig)	Average Deactuation Pressure (psig)	Specified Deactuation Pressure (psig max.)
1	91700	1.99	2.00(±0.01)	2.52	3.00
2	91701	1.99	2.00(±0.01)	2.82	3.00

Table 7-3. Vibration Functional Test Operating Pressures

TEST AXIS	TEST	Specimen 1		Specimen 2	
		Average Actuation (psig)	Average Deactuation (psig)	Average Actuation (psig)	Average Deactuation (psig)
X	Sine	*1.91	2.75	*1.92	2.90
	Random	*1.92	2.72	*1.67	*3.02
Y	Sine	2.01	2.64	*1.72	*3.02
	Random	*1.96	2.64	*1.72	*3.04
Z	Sine	*2.02	2.72	*1.82	*3.02
	Random	*2.03	2.65	*1.82	2.72

* Out of Tolerance

Specification Levels

Actuation: 2.00(±0.01) psig

Deactuation: 3.00 psig max

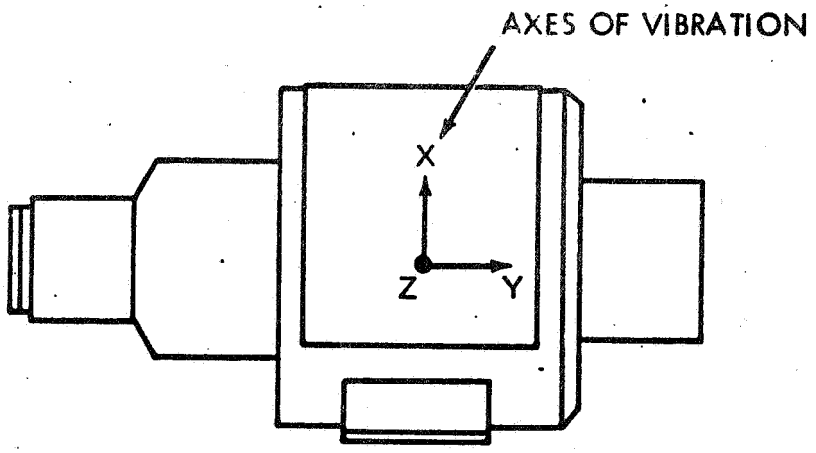


Figure 7-1. Axes of Vibration

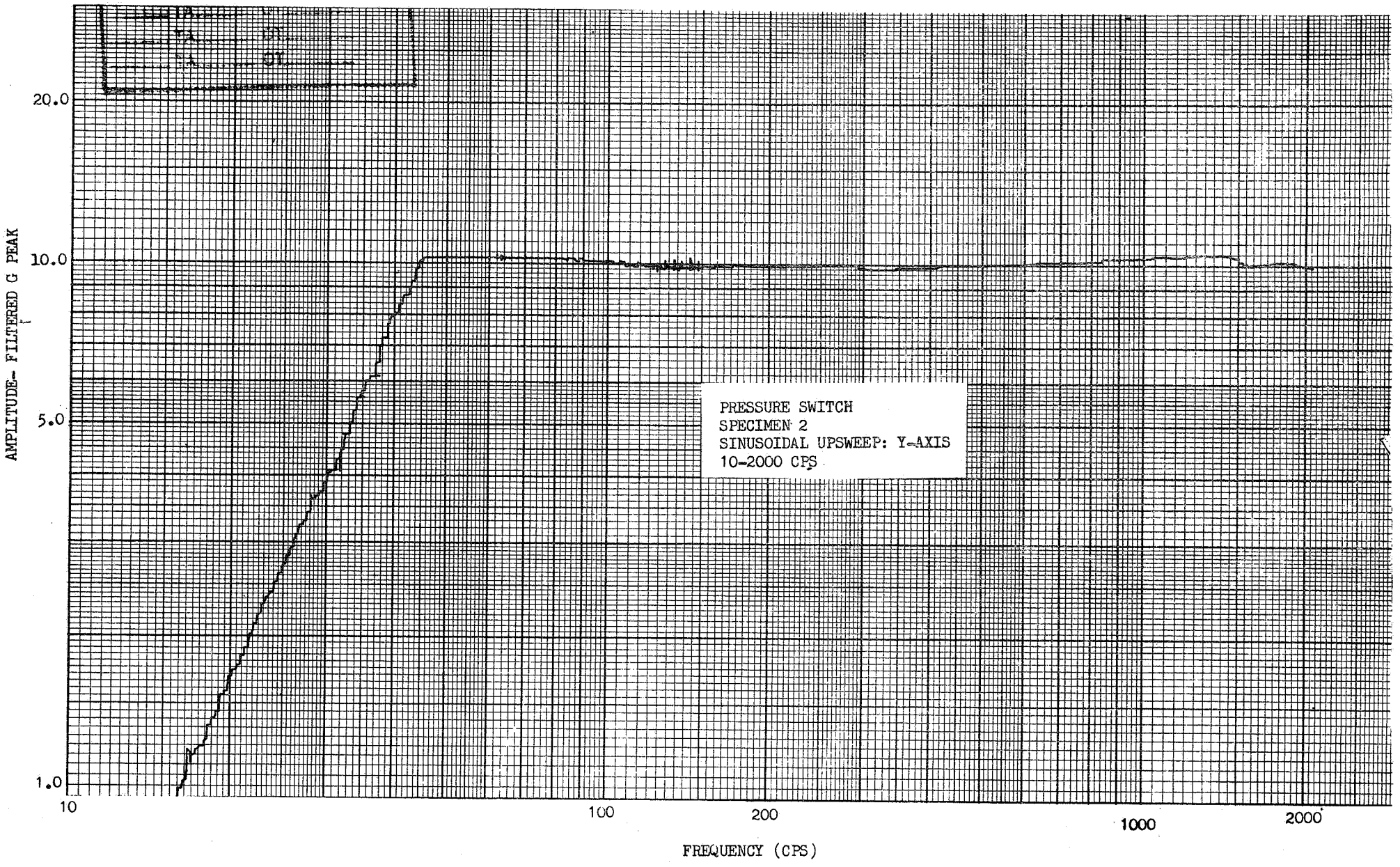


Figure 7-2. Typical Vibration Input Plot (Control Accelerometer)

Figure 7-3. Typical Random Equalization Plot

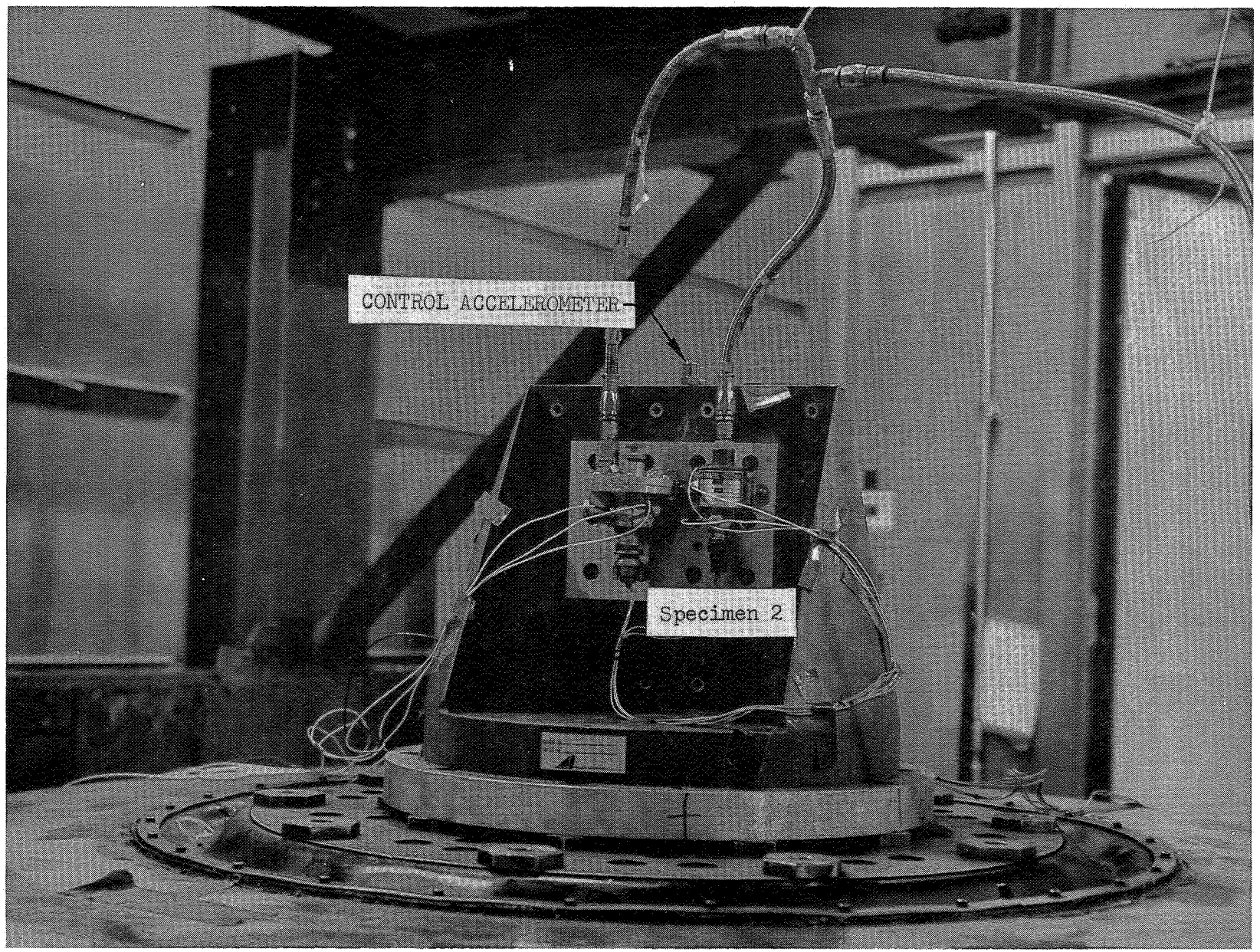


Figure 7-4. Vibration Test Setup (X-Axis)

SECTION VIII

SALT FOG TEST

8.1 TEST REQUIREMENTS

8.1.1 Test specimens 1 and 3 shall be subjected to a salt fog test to determine the extent, if any, of the degradation or deterioration. resulting from the environmental exposure.

8.1.2 The salt solution shall be a 5 percent by weight mixture and shall have a pH factor of 6.5 to 7.2. Test temperature shall be 95 (+2,-4)°F.

8.1.3 A functional test as prescribed in Section IV shall be performed prior to exposure (if more than 72 hours has elapsed since the last functional test) and within 1 hour after removal from the salf fog environment.

8.2 TEST PROCEDURE

8.2.1 The test specimens were inspected for corrosion, dirt, and oily films prior to the salt fog test and were cleaned before being installed in the salt fog chamber.

8.2.2 The test specimens were placed in the chamber in a manner which would permit the fog to reach all sides of the specimens without condensate dripping on them.

8.2.3 The specimens were exposed to the salt fog atmosphere for 240 hours.

8.2.4 A functional test was performed according to Section IV. Paragraph 4.1.6 was omitted.

8.2.5 The test specimens were inspected for corrosion caused by exposure to the salt fog atmosphere.

8.3 TEST RESULTS

8.3.1 The test specimen identification plates were slightly corroded. No rust was detected.

8.3.2 Test Specimens 1 and 3 actuated below the level specified in 4.1.1 after the salt fog test.

8.3.3 The specimens were reset to specification levels after the adjustability test.

8.4 TEST DATA

Data recorded during the salt fog functional tests are presented in Tables 8-1 and 8-2.

Table 8-1. Salt Fog Functional Test Operating Pressures

Salt Fog Test	Specimen 1		Specimen 3	
	Average Actuation (psig)	Average Deactuation (psig)	Average Actuation (psig)	Average Deactuation (psig)
Before	*2.03	2.65	2.00	2.74
After	*0.72	1.52	*1.47	2.38

*Out of Tolerance

Specification Levels:

Actuation: 2.00(±0.01) psig

Deactuation. 3.00 psig max.

Table 8-2. Adjustability Test Data Obtained After Salt Fog Test

Specimen Number	Serial Number	Maximum Actuation Pressure (psig)	Specified Actuation Pressure (psig min.)	Minimum Actuation Pressure (psig)	Specified Actuation Pressure (psig max.)
1	91700	7.02	2.20	0.22	1.80
2	91701	6.30	2.20	0.17	1.80
3	91702	6.45	2.20	0.17	1.80

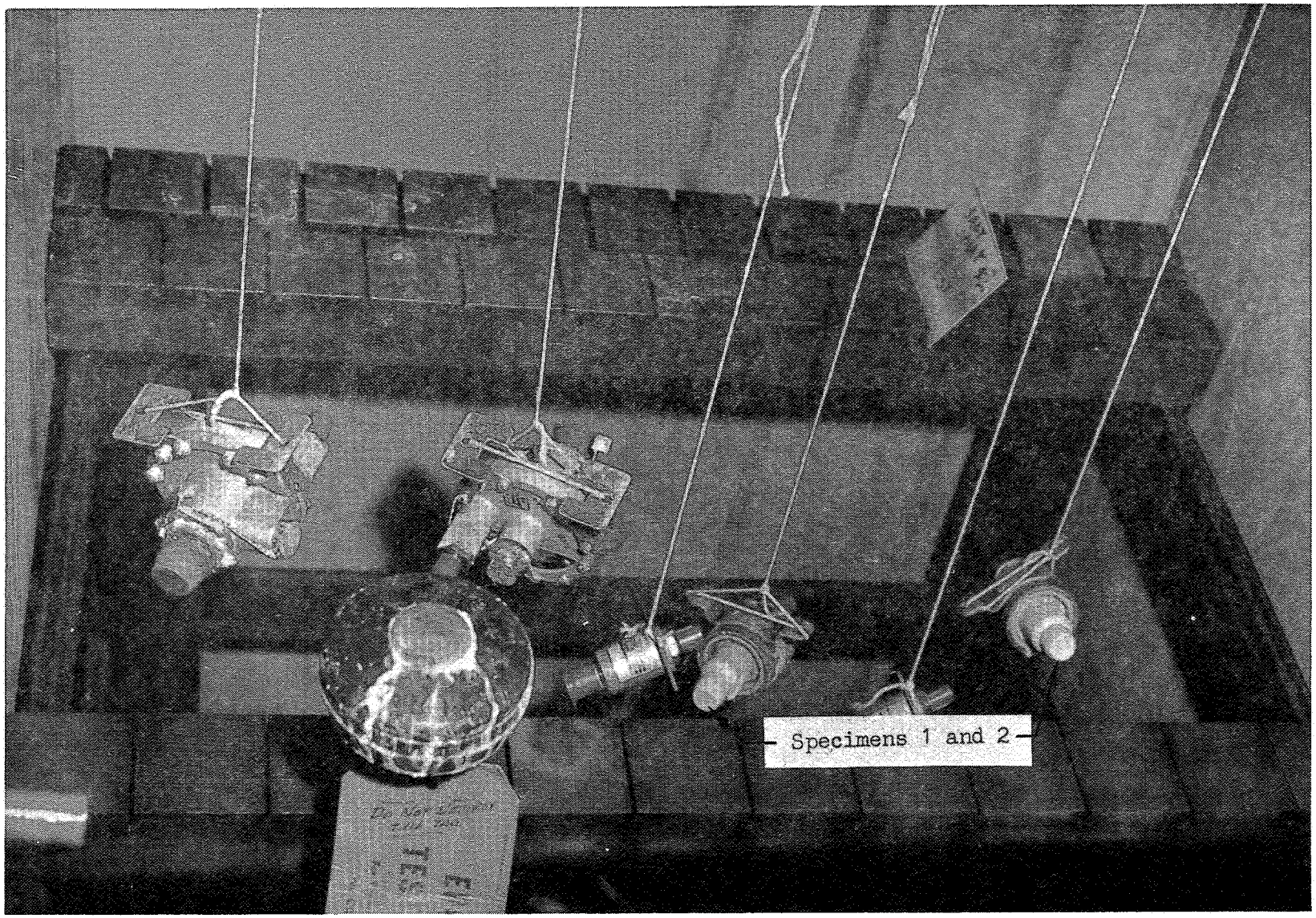


Figure 8-1. Salt Fog Test Setup

Table 9-1. Explosion Test Functional Operating Pressures (Specimen 2)

Explosion Test	Average Actuation Pressure (psig)	Specified Actuation Pressure (psig)	Average Deactuation Pressure (psig)	Specified Actuation Pressure (psig max)
Before	2.00	2.00(+0.01)	2.77	3.00
After	* 2.02	2.00(+0.01)	2.73	3.00

* Out of Tolerance

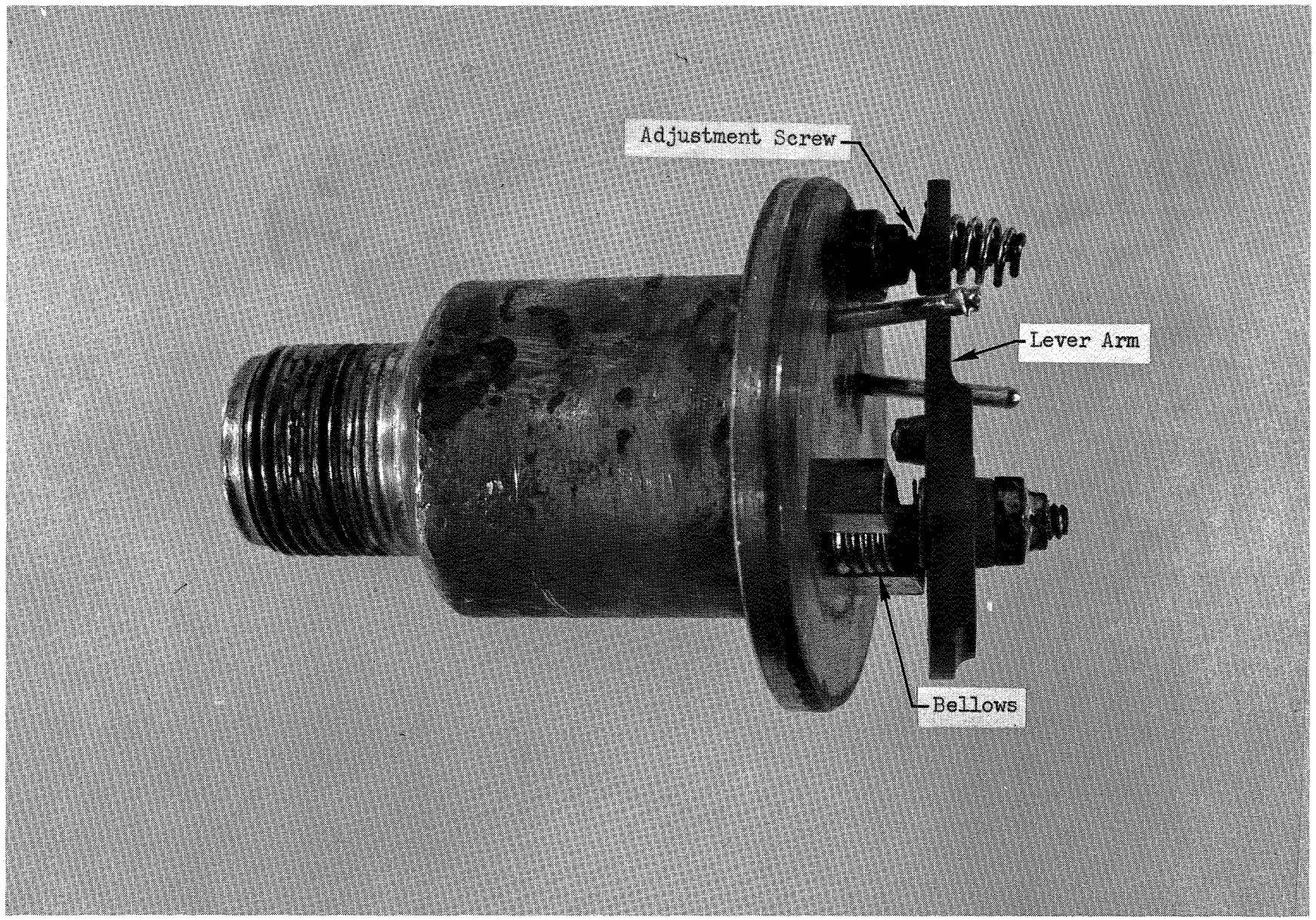


Figure 9-1. Broken Bellows Assembly (Specimen 1)

SECTION X

CYCLE TESTS

10.1 TEST REQUIREMENTS

10.1.1 Specimens 2 and 3 shall be subjected to 5000 cycles of operation. A cycle shall consist of one actuation and one deactuation of the specimen.

10.1.2 The contacts of each specimen shall have a 28-vdc, 5-ampere resistive load applied during the cycle test.

10.1.3 A functional test as prescribed in Section IV shall be performed prior to the cycle test and following each 1000 cycles of operation. Paragraphs 4.1.6 and 4.1.7 be omitted except for the last functional test.

10.2 TEST PROCEDURE

10.2.1 The test setup was assembled as shown in Figures 10-1 and 10-2 using the equipment listed in Table 10-1.

10.2.2 The resistive loads were adjusted to limit the current through the specimen contacts to 5 amperes.

10.2.3 The repeat cycle timers were adjusted so that the specimens were actuated for 3 seconds and deactuated for 3 seconds during each cycle.

10.2.4 Pressure regulator 3 was adjusted to limit the pressure to 10 psig.

10.2.5 The specimens were monitored for proper operation using even recorder 8.

10.2.6 A functional test was performed after each 1000 cycles of operation.

10.3 TEST RESULTS

10.3.1 Specimen 3 would not function prior to the cycle test. X-rays of the specimen revealed salt residue on the adjustment screw and spring which prevented normal operation of the specimen. Specimen 3 was removed from the cycle test and replaced with specimen 1.

10.3.2 The actuation pressure of specimen 1 was out of tolerance after 1000 cycles of operation. The actuation pressure was not reset during the cycle test.

10.3.3 The actuation pressure of Specimen 2 was out of tolerance after 4000 cycles of operation, The actuation pressure was not reset during the cycle test. The contact voltage drop between pins A and B was approximately 0.890 volts during the functional tests performed after 2, 3, 4, and 5 thousand cycles.

10.3.4 Specimens 1 and 2 were adjustable to the levels specified in 4.1.7.

10.4 TEST DATA

Data recorded during the cycle test are presented in Tables 10-2 and 10-3.

Table 10-1. Cycle Test Equipment List

Item No.	Item	Manufacturer	Model/ Part No.	Serial No.	Remarks
1	Test Specimens 1 and 2	Paramatic, Inc.	AP 535-4	91700, 91701	Pressure Switch
2	Gaseous Nitrogen and Helium	NA	NA	NA	10-psig
3	Pressure Regulator	Grove	15-LX	104859-9	0-to 300-psi
4	Pressure Gage	Wallace-Tierman	FA 234	HH11924	0-to 50-psig ±0.1% FS Cal date 9-12-67
5	Solenoid Valve	Marotta Valve	MV100	NA	1/4-inch
6	Solenoid Relief Valve	Marotta Valve Corp.	MV109	NA	1/4-inch
7	Repeat Cycle Timers (2)	Industrial Timer Corporation	ET-15S	NA	3 seconds each
8	Event Recorder	Techni-Rite Electronics	TR120	010461	
9	Power Supply	Perkin Electronics	NA	63-293	28-vdc, 10-amps
10	Load Bank	CCSD	NA	NA	5-amp, 28-vdc
11	Ammeter	Simpson	HA	NA	0-to 10-ampere ±1% FS (built into load banks)

Table 10–2. Cycle Test Functional Operating Pressures (Specimen 1)

Number of cycles	Average Actuation Pressure (psig)	Specified Actuation Pressure (psig)	Average Deactuation Pressure (psig)	Specified Deactuation Pressure (psig max.)
0	2.00	2.00(±0.01)	2.55	3.00
1000	*1.95	2.00(±0.01)	2.55	3.00
2000	*1.95	2.00(±0.01)	2.45	3.00
3000	*2.05	2.00(±0.01)	2.55	3.00
4000	2.00	2.00(±0.01)	2.50	3.00
5000	*1.95	2.00(±0.01)	2.45	3.00

*** Out of Tolerance**

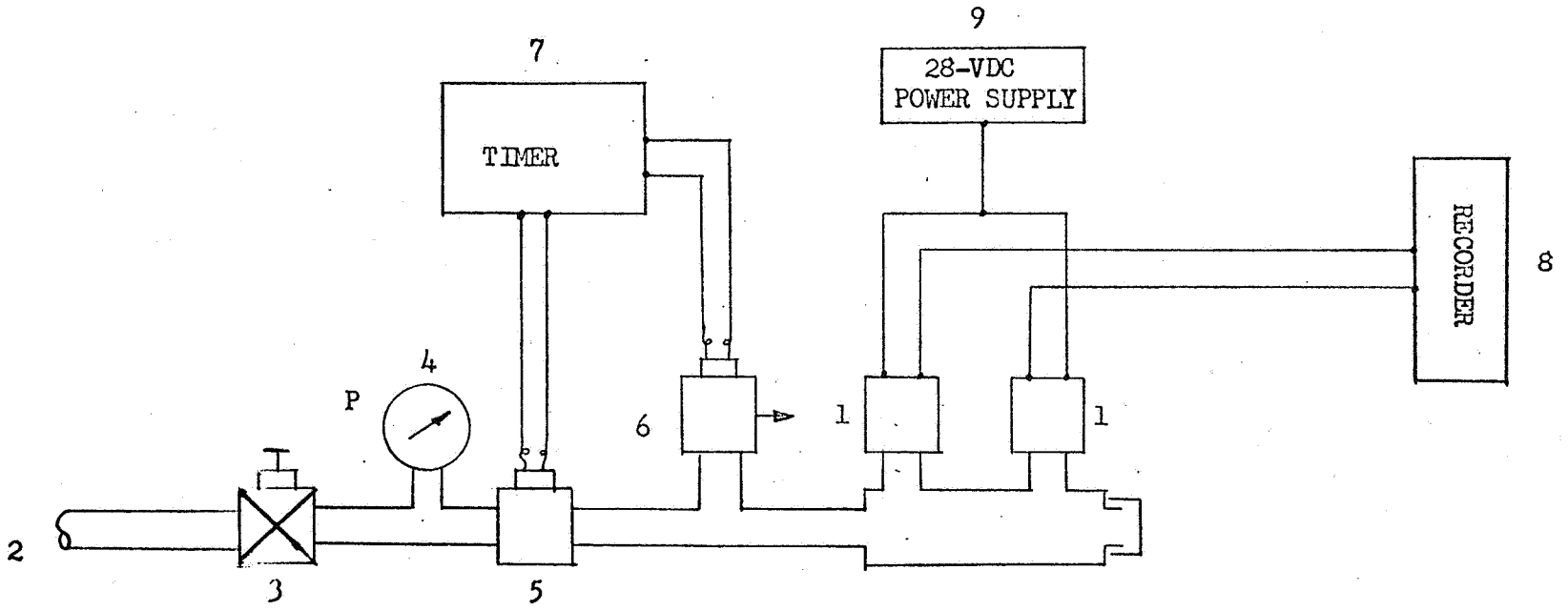
Table 10-3. Cycle Test Operating Pressures (Specimen 2)

Number of Cycles	Average Actuation Pressure (psig)	Specified Actuation Pressure (psig)	Average Deactuation Pressure (psig)	Specified Deactuation Pressure (psig max.)
0	2.00	2.00 (±0.01)	2.80	3.00
1000	2.00	2.00 (±0.01)	2.80	3.00
2000	2.00	2.00 (±0.01)	2.65	3.00
3000	2.00	2.00 (±0.01)	2.80	3.00
4000	*2.10	2.00 (±0.01)	2.80	3.00
5000	*2.10	2.00 (±0.01)	2.80	3.00

* Out of Tolerance

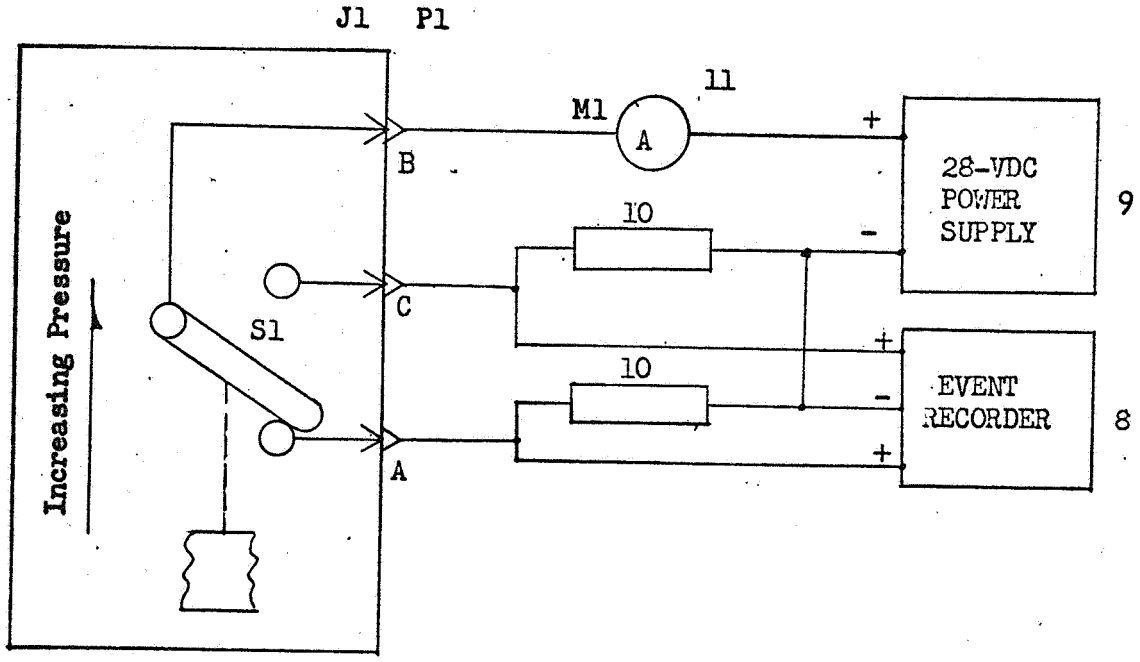
Table 10-4. Adjustability Test Data Obtained After Cycle Test

Specimen Number	Serial Number	Maximum Actuation Pressure (psig)	Specified Actuation Pressure (psig min)	Minimum Actuation Presssure (psig)	Specified Actuation Pressure (psig max.)
1	91700	6.82	2.20	0.10	1.80
2	91701	6.15	2.20	0.25	1.80



Note: Refer to Table 10-1 for item identification.

Figure 10-1. Cycle Test Schematic



Note: Refer to Table 10-1 for item identification.

Figure 10-2. Typical Electrical Connection for Cycle Test Schematic

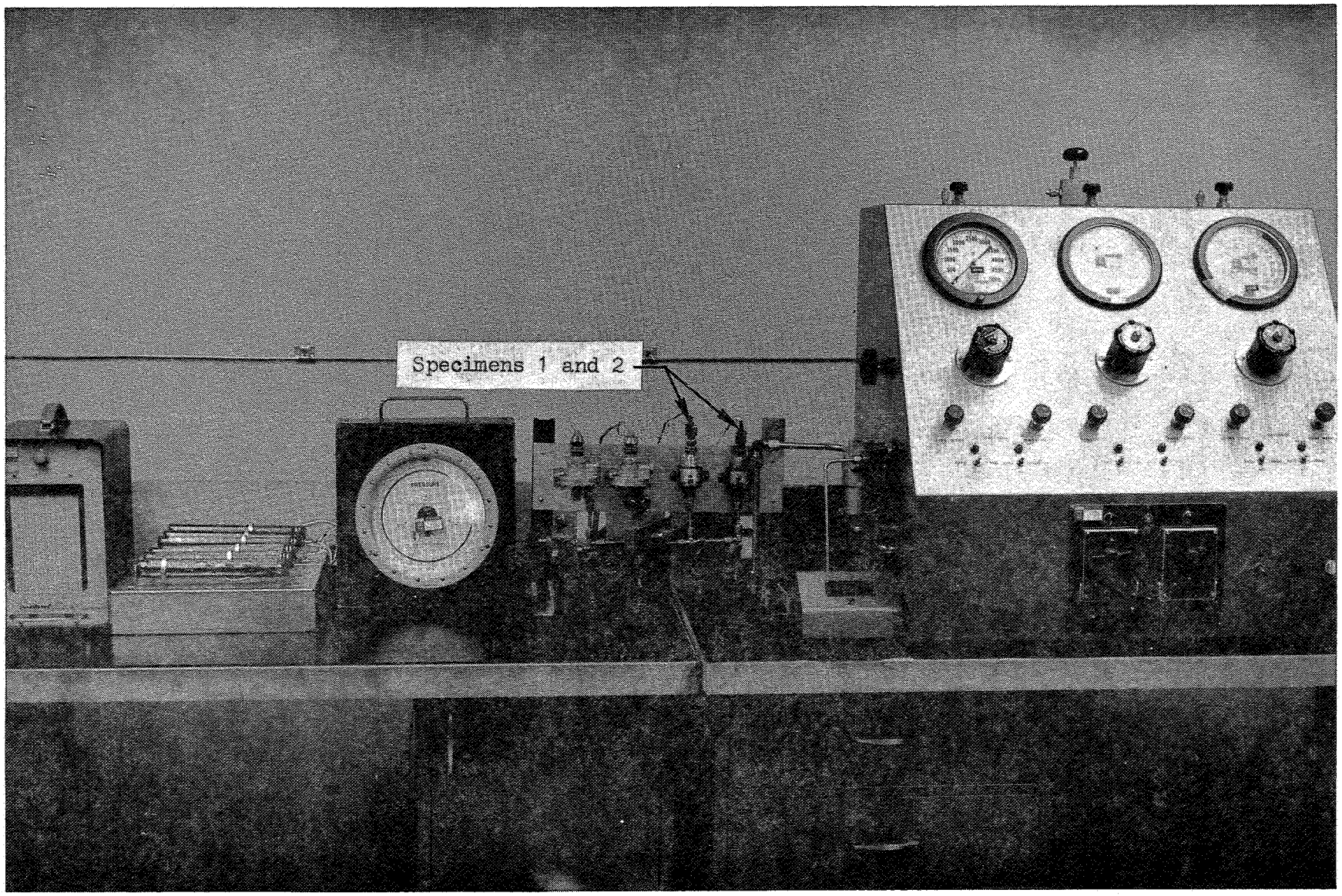


Figure 10-3 Cycle Test Setup

APPROVAL

TEST REPORT

FOR

PRESSURE SWITCH

Parmatic. Inc Part Number AP535-4

NASA Drawing Number 75M04044-HPS-1

SUBMITTED BY:

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